OPERATOR'S MANUAL

STANDARD 2400-HP. TRANSFER DIESEL-ELECTRIC LOCOMOTIVES

BALDWIN-LIMA-HAMILTON CORPORATION
EDDYSTONE DIVISION
PHILADELPHIA 42, PA.

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O P E R A T O R ' S M A N U A L

NO. DT-101

STANDARD 2400-HP. DIESEL-ELECTRIC

TRANSFER LOCOMOTIVES

with

Dynamic Braking
CE-100 Control Stand
24-RL Brake Equipment
Multiple Unit Control
Dual Control Stands

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BALDWIN-LIMA-HAMILTON CORPORATION
PHILADELPHIA, PA.

July 24, 1951

P R E F A C E

This manual describes normal routine operation, and certain emergency procedures, for the standard transfer locomotive.

Extra equipment, such as dynamic braking and multiple unit controls are inserted in the regular text, when possible, on an "if installed" basis. Separate alternative paragraphs are written when necessary. Crews can readily omit references to items not on their locomotive without affecting the remaining instructions. Standard instructions for M.U., double-heading, pushing, towing, or changing cabs are for 24-RL brake equipment.

This book does not include maintenance information or shop procedures which are covered in separate publications for the diesel engine and auxiliary equipment.

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GENERAL DESCRIPTION

INTRODUCTION

The 2400-horsepower diesel electric transfer locomotive is powered by two six-cylinder supercharged, four-cycle engines, with direct connected main generators. The running gear consists of two six-wheel trucks. A complete engine-generator set with its independent cooling, lubricating and fuel supply systems, and similar auxiliary equipment is called a "power unit". The term "engine" is used to refer to the diesel engine only. Two complete units comprise the locomotive. They are under one control system but are otherwise independent. Locomotives may be equipped for dynamic braking and multiple unit operation.

LOCOMOTIVE CONTROLS

The regularly used manual controls are located in the cab, or on the engine control panel. The principal controls are the master controller, the control stand switches, air brakes and miscellaneous cab equipment, the engine control panel, and switches in the electrical equipment cabinet.

When two sets of controls are provided in the cab, the locomotive may be completely controlled in any direction from either position. However, only one position at a time is operative, since

the non-controlling position is interlocked out of action.

MASTER CONTROLLER

The master controller at the engineer's position is equipped with a throttle and reverse lever which control the speed and power of the locomotive and its direction of travel.

The throttle acts pneumatically on the speed control shaft of the engine governor. It is advanced smoothly through an infinite number of positions, enabling the operator to handle a train more smoothly than with a notched throttle rendering stepped application of power. No transition is necessary.

The reverse lever usually has three positions, Forward, Reverse and Off, which are clearly marked. On locomotives equipped for dynamic braking, an additional position, plainly marked, is provided to establish proper electrical connections in the braking circuit. The reverse lever is mechanically interlocked with the throttle lever so that it cannot be moved except when the throttle is off.

BRAKES

Air Pressure Gauges for (a) the Brake Pipe and Cylinder and (b) the Main and Equalizing Reservoir are located on the instrument panel in front of the engineer.

The automatic brake valve is located near the top of the brake pedestal in front of the engineer's position, with the lever at the engineer's right hand.

The independent brake valve is mounted between the automatic brake valve and the master controller. It controls the locomotive brakes only.

A Rotair valve is mounted on multiple unit equipment only. This valve is manually operated to adjust braking power to the particular requirements of the service in which the locomotive is being operated.

A hand brake is situated on the side of the cab.

CIRCUIT BREAKERS

Breaker type switches are used to protect various electrical circuits, thereby eliminating fuses. These switches open automatically when overloaded, and are closed manually. After opening, they must be moved to full "off" position before being reclosed. Switches in the following circuits are usually breakers.

Main control circuit (35 amp. switch in cabinet)
Fuel Pump Motor
Fan Motor (power)
Auxiliary Generator (power)
Auxiliary Generator Field
Ground Relay Cut-out
Power Cut-out
Cab, gauge-number, marker and hood lights

MISCELLANEOUS CAB CONTROLS

The horn, bellringer, window wipers, defrosters, cab heaters, headlight and sanders are typical miscellaneous items of equipment controlled from the cab. Hot water cab heaters are equipped with electric fans whose speed can be controlled by rheostats in the cab. A breaker type switch (usually in the cabinet) feeds both heater circuits. Slight changes may be required from standard cab layout if there are many controls for extra equipment such as window washers, train control, train communication, cab signals, etc.

A speed indicator is mounted in the cab to show locomotive speed. Extra equipment which may be installed in conjunction with the indicator are a tape recording device, and an automatic brake application feature.

ENGINE CONTROL PANEL

The control panel on the wall of the cab next to its respective engine contains switches for starting, stopping, and idling the engine, connecting the fuel pump motor to its power supply, and manually controlling the fans. Gauges, indicating lights and switches for other miscellaneous purposes, as designated by their nameplate, are on or near the panel.

ELECTRICAL EQUIPMENT CABINET

There are two electrical equipment cabinets which open into the cab of the locomotive. In general, each power unit has its own cabinet, and the two cabinets are similar to each other except for certain items which serve both units. All items of electrical equipment may be found in the cabinets or on the adjacent control panel, unless otherwise designated in the descriptions which follow.

The manually controlled switches inside the standard equipment cabinet are the battery switch, power cutout switch and breakers in the auxiliary generator, fan and lighting control circuits.

SAFETY NOTICE

High voltages are used on much of the equipment in the cabinets. Cabinet doors should be kept closed as much as possible. No attempt should be made by unqualified personnel to open the doors or make adjustments to equipment.

BATTERY

Each locomotive is equipped with a 64 volt storage battery mounted under trap doors outside the cab. A manually operated, double-pole, single-throw knife switch, located in one of the electrical equipment cabinets, disconnects the

battery from most of the electrical circuits of both units. Energy for starting the engine is obtained from the battery. Pressing the engine start button on the control panel closes the engine starting contactors which connect the main generator to the battery. The generator acts as a motor while cranking the engine.

MAIN GENERATOR

The main generator is a 12-pole direct current, self-ventilated, single bearing generator directly connected to the diesel engine by a coupling. It furnishes power over a wide range of speeds up to 625 r.p.m. and rotates in a counter-clockwise direction when viewed from the commutator end. It supplies power to the traction motors and radiator fan motors.

TRACTION MOTORS AND BLOWERS

The traction motor is a direct-current, series-wound, 6-pole motor mounted on, and geared directly to, each driving axle. The motors are cooled by blowers which are belt driven by the diesel engine. Heavy electrical current generates heat which will damage the motors if they are not adequately cooled. The power unit should be isolated or shut down if the blowers are not functioning properly.

AIR COMPRESSOR

An engine driven air compressor maintains a pressure of 125 to 140 pounds in the main reservoir. The air brakes and throttle control system are supplied at main reservoir pressure. The compressor governors are arranged so that all units pump air when low pressure engages any compressor. This is accomplished by piping on single units, and by a train-lined electro-pneumatic valve on multiple units.

Pneumatic control lines at 70 pounds pressure are fed from the high pressure lines through a reducing valve. The reversers and power switches, and cam switches, if installed, are operated from these lines.

TURBOCHARGER

Each engine is supercharged by a turbocharger, a self-contained unit consisting of a gas turbine and centrifugal blower rotating on a common shaft. The unit is located at the end of the engine over the main generator. The turbine uses the energy in the exhaust gases to drive the blower, which supplies air to the engine cylinders at a pressure above atmospheric pressure. It is lubricated by the engine lubricating system and cooled by the engine cooling system. There are two water drain cocks, one in the cooling system and one for condensation.

32-VOLT POWER

A motor-generator set, if installed, operates from the battery to supply 32-volt power for special circuits for cab signals and communication equipment when required. A breaker-type switch in the input line near the m-g starting panel controls the set. Specific instructions are generally issued locally for such equipment.

MULTIPLE UNIT OPERATION

Locomotives equipped for multiple unit operation may be handled as a single locomotive after connections are properly made. In addition to the conventional coupling of locomotives and air lines, the electrical control circuits of the two locomotives must be connected. A jumper for this purpose must be firmly plugged into the receptacles at the end of the locomotives. The controls are then set so that both the power and brakes are controlled from only one cab. The locomotive from which operation is controlled is called the leading unit, and any coupled locomotives are trailing units. Certain alarm and protective circuits, and certain auxiliary controls, such as sanding, are connected through the jumper, but the power plants and heavy duty circuits of the coupled units remain entirely independent of each other.

GENERAL DATA

DIESEL ELECTRIC

TRANSFER LOCOMOTIVE

BLH LOCOMOTIVE CIASSIFICATION.....	RT-624
GAUGE	4' - 8-1/2"
WHEEL ARRANGEMENT.....	0-6-6-0
DIESEL ENGINES ..... Two 1200 H.P. 6 Cylinder In-Line Supercharged Engines	2400 H.P. Model 606 SA
MAIN GENERATORS.....	Westinghouse 480-FZ
TRACTION MOTORS..... Six	Westinghouse 370-DZ
GEAR RATIO.....	15:63 15:68
MAXIMUM SPEED	60 M.P.H.
TRACTIVE EFFORT Starting at 30% Adhesion (Without Dynamic Braking Equipment).....	106,200 Lb.
DYNAMIC BRAKING EFFORT (if installed) Approx. Max.	15:68 Gear Ratio-66,400 Lb. 15:63 Gear Ratio-61,500 Lb.
CURVES, MINIMUM RADIUS.....	260' - 22°

WHEELS

Driving	6 Pairs
Diameter	42"

WHEEL BASE

Each Truck	13' - 0"
Total Locomotive	54' - 9"

LOCOMOTIVE DIMENSIONS

Length, Over Coupler Knuckles	74' - 0"
Height, Max. Overall	15' - 4¼"
Width, Max. Overall	10' - 2"

WEIGHTS

Locomotive in Working Order	354,000 Lb.
Traction Motor, Gear & Axle Bearings	7,370 Lb.
Pair of Wheels and Gear on Axle with Boxes	5,100 Lb.
Diesel Engine	32,500 Lb.
Main Generator	11,200 Lb.
Auxiliary Generator and Exciter	800 Lb.
Diesel Engine Power Unit, comp.	44,500 Lb.
Brake Air Compressor	1,300 Lb.
Radiator Fan & Motor Ass'y	1,150 Lb.

SUPPLIES

Fuel Oil	1,500 Gal.
Engine Cooling Water (Two Engines)	500 Gal.
Engine Lubricating Oil (Two Engines)	340 Gal.
Air Compressor Lubricating oil (One Compressor)	7 Qt.
Sand	45 Cu. Ft.

LOCOMOTIVE OPERATION

SUMMARY OF OPERATING PROCEDURE

TO START DIESEL ENGINE

1. Close the battery switch.
2. Throw fuel pump switch and engine control switch on. Leave auxiliary generator field switch off.
3. Check that throttle and reverse lever are in the off position.
4. Press engine start button firmly until lube oil pressure reaches 20 pounds.
5. Close auxiliary generator field switch.

TO MOVE LOCOMOTIVE

1. Close control switch at controlling position only.
2. Check air pressures and make brake test.
3. Move reverse lever to desired direction.
4. Release brakes; advance throttle slowly.
5. Come to full stop before reversing. Reverse lever is interlocked so it can not be moved except when throttle is off.
6. Keep ammeter within posted load limits.
7. Check gauge readings regularly.
8. Retard throttle to decrease power for stop or slowdown.

TO SHUT DOWN LOCOMOTIVE

1. Shut down each power unit at its control panel.
   a. Throw engine control switch off.
   b. Open fuel pump switch.
   c. Open auxiliary generator field switch.
2. Open control switch beside controller.
3. Open battery switch.
4. Remove reverse lever.

GENERAL

All essential controls for the normal operation of the locomotive are summarized on the preceding page. More detailed information is given on subsequent pages. The regularly used manual controls are located in the cab. Other manual controls are largely for emergency use, and are adequately described under their respective headings.

The throttle increases or decreases the speed and power output of the engine by pneumatic action on the governor. The electrical connections of the throttle are arranged so that, in its off position, the power switches are opened and the traction motors are disconnected from the main generator.

The reverse lever, whose positions are marked, controls the pneumatically actuated reverser in the equipment cabinet. Turning the reverser changes the connections of the traction motor fields, which determines the direction of rotation, and therefore the direction of locomotive movement. If the locomotive is equipped for dynamic braking, the reverse lever also controls a pneumatically actuated cam switch in the power circuits. A latch under the reverse lever must be tripped to move the lever to braking position.

Units in multiple must have their pneumatic and electric systems properly connected. Under such conditions, the

control circuits and emergency shutdown circuits through the control stand, and various indicating lights, audible indicators and automatic controls are train-lined to all locomotive units.

ENGINEER'S POSITION

The throttle, reverse lever and air brake equipment, which were mentioned in the general description, are familiar to operators of practically all types of motive power. In addition, the function of the following electrical equipment in the power circuits of diesel-electric locomotives should be understood by all operators.

Control Switch - The control switch beside the master controller must be closed to establish power control through the controller. Whenever it is closed, all other controllers in multiple are automatically interlocked out of action.

Emergency Engine Shutdown Switch - (on M.U. equipment only) - The shutdown switch on each control stand shuts down all engines in multiple, and is provided for emergency use in stopping engines. It will function from any unit in multiple, regardless of which unit is controlling.

Load Ammeter - The load ammeter on the engineer's instrument panel indicates the amount of current flowing through the traction motors. Each power unit has its own ammeter. The readings of this meter must be kept within allowable load limits, as posted in the cab.

Wheel Slip Buzzer - The wheel slip buzzer on all units in multiple sounds when any wheels are slipping. Power on the slipping unit only is automatically reduced momentarily, and then increased to the original load. If the wheels continue to slip, the throttle should be retarded enough to eliminate slipping. Do not apply sand while wheels are slipping.

ENGINE CONTROL PANEL

Each power unit has its own control panel mounted on the wall of the cab next to its respective engine. In addition to the switches which are used in specific operations as described later, the crew should check the following meters or gauges.

The battery ammeter, indicating the rate of charge or discharge of the battery, should be observed at least once every three hours. With the engine running, it should indicate either zero, or varying charge readings, depending on the condition of the battery. Continuous discharge of 10 to 15 amperes will not open the reverse current contactor (a protective device) but will drain the battery. Excessive continuous charge (about 50 amperes) may be due to a poor condition of the batteries or voltage regulator, which should be checked by a maintainer. Such readings when observed should be reported at the end of the run.

One battery ammeter serves both units. A selector switch connects the ammeter to either the No. 1 or No. 2 circuit, or to the battery circuit which is common to both units.

Gauges indicate temperature of the water system, or pressure in the fuel oil, lubricating oil, or turbocharger oil lines. Any significant deviation from pressures as recommended on page 213 should be investigated.

A stack switch, if installed, closes when temperature of the engine exhaust becomes excessive. The regular alarm bell will ring. To determine whether the alarm is due to high temperature of the exhaust gases, press the stack switch cutout button in each unit, to see whether the alarm ceases. If so, operate with the throttle sufficiently retarded to avoid an alarm with the cutout button released.

DETAILS OF OPERATION

1. PRELIMINARY

Adequate supplies and proper maintenance are necessary for satisfactory operation of the locomotive. Make sure that the locomotive is ready for operation by conducting the following routine inspections.

A. Check for oil or water leaks. Leaks are more probable on a warm engine under pressure, and if observed under such conditions, should be reported. Check supplies.

1. Fuel oil.
2. Lubricating oil in engine crankcase.
3. Lubricating oil in air compressor crankcase.
4. Oil level in engine governor.
5. Engine cooling water.
6. Sand.

B. Check that condensate is drained from air reservoirs.

C. Turn on lights if necessary. Cab, cabinet and marker lights are fed from the battery through their individual switches. Most other lights will burn only when the battery switch and lighting breaker are closed.

D. Check that the following switches in the electrical equipment cabinet are in their normally "on" or closed position.

1. Control breaker.
2. Power cutout switch.
3. Auxiliary generator power breaker.
4. Fan motor breaker.
5. Fan differential cutout switch (if installed),(or dynamic brake C-O Sw.)

E. For single unit operation, set the Controlled Emergency Cut-off Cock portion (non M.U. Equipment), or the Rotair Valve (M.U. Equipment) in either Passenger or Freight position, according to the service.

F. For M.U. operations, when so equipped, check that all trailing units are properly connected.

1. Electrical train-line jumpers must be in place.
2. Brake piping must be properly trainlined through the end connections.
3. Remove handles of brake valves and reverse lever from trailing units.
4. Set the Rotair Valve as follows:

Type K-2-A: Set the valve in Freight Lap or Passenger Lap, according to the position of the valve on the leading unit.

II. STARTING ENGINES

Before starting engines, make sure that outside battery charging receptacle is disconnected. Start each engine independently at its respective engine control panel.

NOTE: If it is ever necessary to start the engine from an outside source of power, be sure the outside circuit is able to carry the heavy current involved.

1. Check that throttle and reverse lever are in their off position. On M.U. equipment, check that emergency shutdown switch at the control stand is not closed.
2. Close battery cutout switch in the equipment cabinet.
3. The control panel switches must be set as follows:
   a. Auxiliary generator field switch - Off.
   b. Radiator fan and shutter switch- Auto.*
   c. Ground relay cutout switch - On (normally).
   d. Engine control switch - On or Idle. (Preferably Idle)
   e. Fuel supply pump switch - On. Fuel pressure gauge should read at least 20 pounds.
4. Press engine start button firmly until lube oil pressure reaches 20 pounds. If the button is released before pressure reaches 20 pounds, oil pressure switch will automatically stop the engine. CAUTION: If engine does not turn, release start button immediately. Should engine fail to fire within 10 seconds, release start button and determine the reason. See Operating Difficulties.

* If engine is hot, set switch off till after step 5, so fan motors don't drain battery.

5. Place auxiliary generator field switch in the "on" position. This should charge the battery.

Upon starting, battery charging ammeter will register current between 5 and 50 amperes. Reading will approach zero as batteries become fully charged.

III. TO PUMP AIR AT HIGH RATE OR CHECK ENGINE SPEED RANGE

With the locomotive at standstill, or coasting down grade, the diesel engine can be operated above idling speed for the purpose of pumping air at a high rate. With the control switch closed, and the reverse lever off, advance the throttle slowly until required pumping rate is reached. The engine speed will increase after the throttle has advanced about 40° from the off position. The engine speed is similarly increased for checking the engine speed range or making an engine load test. (On locomotives with two control stands, if the throttle at the No. 2 position is used, the No. 2 control switch must be closed.)

IV. MOVING THE LOCOMOTIVE

A. Before starting, inspect the locomotive as follows:
   1. Check oil pressure gauge readings.
   2. The engine cooling water temperature should be between 145° and 165° on an idling engine.
   3. Air pressure should be 140 pounds in main reservoir, and 70 pounds in the control system.

4. Check both automatic and independent brake valve application and release.
5. Release hand brakes.
6. Test horn, bell ringer, sander and windshield wipers.
7. Radiator fans and shutters should operate properly. Non-automatic operation, which is described later, should be reserved for emergency.
8. The traction motor blowers should be operating properly. A LOCOMOTIVE MUST NOT HAUL A TRAIN UNLESS TRACTION MOTORS ARE ADEQUATELY COOLED.
9. Engine control switch must be Power-On (if engine was started in Idle, or subsequently isolated).

B. Check that control switch at engineer's position is "on" (and corresponding switch at the other control stand is "off", on locomotives with two controllers). Move reverse lever to the forward or reverse position, depending on the desired direction of travel.
C. Release air brakes.
D. Move throttle to first notch and hold until load ammeter indicates a flow of current. It takes about four seconds for the power circuits to close.
E. When the ammeter registers current, slowly advance the throttle to handle the train smoothly, and keep the current within allowable load limits.

F. Several steps of field shunting occur automatically as locomotive speed increases. There is no transition of power circuits, and manual control of power is exercised entirely through the throttle.
G. Retard the throttle to reduce power when stopping, slowing down, or eliminating wheel slip. Avoid wheel slip if possible.
H. If wheel slip occurs, buzzer will sound, and power will automatically decrease until slipping stops. Power is then automatically restored. If wheel slip recurs, retard throttle. Do not apply sand.

V. SANDING

DO NOT APPLY SAND WHILE THE WHEELS ARE SLIPPING

Sand is a preventive, not a corrective measure. Always use sand sparingly. The even starting torque of the diesel electric locomotive makes the use of sand seldom necessary. There are several types of sanding installations, chief among which are

1. Entirely pneumatic, controlled by the brake valve or separate sanding valve, on non-multiple-unit equipment.

2. Standard multiple unit, electrically controlled by foot switch to energize electro-pneumatic sanding magnet valves. The valves are electrically interlocked with the reverser so that sand is automatically applied to the leading wheels only.

3. For automatic or bail sanding features (combined with 2 only), add an electro-pneumatic switch in the sanding circuit.

VI. ELECTRICAL LOAD LIMITS

The locomotive may be operated for an indefinite time at loads within the continuous rating. Any reading of the load ammeter in excess of the continuous rating constitutes an overload. Electrical apparatus will safely carry an overload for a limited time if maximum allowable temperature has not been reached. Overheating due to excessive loads can result in serious damage to the equipment which may not be apparent immediately, but can cause failure later on. A table of allowable load limits under full cooling (i.e., full engine speed) is posted in front of the engineer. ENGINEERS SHOULD ALWAYS KEEP WITHIN POSTED LOAD LIMITS. When the time limit is reached for any overload, no overload capacity exists at any other amperage above continuous rating. The engine must then be idled to cool the electrical equipment unless the train can continue at full engine speed at or below the continuous rating.

VII. INSPECTIONS DURING OPERATION

A. Check gauges frequently. Investigate and report any great deviation from normal.

1. Lubricating oil pressure, engine - Normal 50 to 55 pounds at the gauge at full engine speed when normal operating temperature has been reached.
2. Lubricating oil pressure, turbocharger - Normal 22 to 25 pounds at full engine speed.
3. Fuel oil pressure - Normal 25 pounds.
4. Control air pressure - Normal 70 pounds.
5. Water temperature - A range of 145° to 180° is automatically maintained by the fan and shutter controls. If water is too hot, engine will run only at idling speed* Try fan and shutter switch in the "on" position, as described under manual operation of the cooling system.

B. Check battery ammeter. It should not show a discharge when engine is running. See page 204.

VIII. TO STOP LOCOMOTIVE

A. Normal stop - Move the throttle gradually to first running position and hold it there until load ammeter indicates that the current has dropped. Then move the throttle off, and apply the brakes in regular service application.

B. Emergency stop - Move the automatic brake valve to emergency position. The power units are automatically idled and disconnected from the motors.

* Standard on M.U. only, see page 220.

IX. RECOVERY AFTER EMERGENCY, OR PENALTY, APPLICATION

A. To resume normal operation after any emergency, deadman, speed control, train control, or similar extra-ordinary brake application.

1. Depress deadman pedal, (if installed).
2. Move throttle to the off position. An air interlock keeps the engines idling until throttle is off.
3. Place automatic brake valve in Lap position until brake application portion releases.

X. REVERSING THE LOCOMOTIVE

A. CAUTION: Do not move the reverse lever while the locomotive is still in motion. Do not drift in one direction with the reverse lever set in the opposite direction. Serious damage to electrical equipment may result if this rule is disregarded.

B. To reverse the locomotive:

1. Move the throttle to the off position.
2. Apply brakes to come to full stop.
3. Change reverse lever to the opposite direction.
4. Release brakes and advance throttle in the normal manner.

XI. TO CUT OUT A LOCOMOTIVE UNIT ENROUTE

A. In event of electrical failure enroute, a locomotive unit can be cut out electrically by isolating it. An isolated unit will have power to pump air, charge batteries, and operate the engine water system to prevent freezing in cold weather.

1. To isolate a unit, place the engine control switch on the control panel in the "idle" position, which reduces engine speed to idling and opens the motor circuits.

B. If the trouble is mechanical, the unit can be shut down entirely. Stop the engine as in XIII below.

A unit may be isolated or shutdown while other units in multiple are working under advanced throttle.

XII. TO RESTORE A CUT OUT UNIT TO SERVICE ENROUTE

After correcting trouble, a power unit may be put back into service ("back on the line") as follows:

A. If the unit is isolated, place the engine control switch in the "on" position.

B. If the engine is shut down, check that the engine control switch is in the idle position, and then start the engine in the usual manner. Then place the engine control switch in the "on" position.

XIII. TO STOP A DIESEL ENGINE

A. The engine of any one unit is NORMALLY stopped by placing the following switches on the control panel in their "off" position.

1. Engine control switch.
2. Auxiliary generator field switch.
3. Fuel pump switch.

B. To stop ALL engines in an EMERGENCY:

1. Close the emergency engine shut-down switch on the control station beside the master controller. (Installed on M.U. equipment only).

XIV. TO CHANGE OPERATING CABS, OR CONTROL STATIONS

A. Cut out the control stand which has been controlling.

1. Make a full service reduction with the automatic brake valve.
2. Place automatic brake valve in lap position and independent brake valve in release position.
3. Place double heading cock in closed (cut out) position.

4. If changing cabs (multiple unit), move K-2-A Rotair Valve to Pass Lap, or Frt. Lap, as required, (or K-2 valve to Lap).
5. Place automatic brake valve in running position and remove both automatic and independent brake valve handles.
6. Open control switch beside master controller, and remove reverse lever.

B. Cut in the control stand which will be controlling.

1. Place Rotair Valve in Pass or Frt., as required, (if changing cabs only).
2. Insert brake valve handles, place independent brake valve in full application position, and open double heading cock.
3. Close control switch. Insert reverse lever.
4. Make brake test.

XV. PUSHER SERVICE OR DOUBLE HEADING SERVICE

In such service, power is controlled on each locomotive independently in the usual manner, but service brakes are controlled by the leading locomotive only. However, brake pipes can be set so that the non-controlling locomotive can release its own brakes only, to avoid sliding or over-heating the wheels. Conform to the standard practice of your road. With 24-RL brake

equipment, place the Rotair Valve or Controlled Emergency Cut-out cock, whichever is installed, in Pass or Frt, depending on the service required, place dead engine cock in live position, and close double heading cock. Place automatic brake valve in Running position and independent brake valve in Release position.

XVI. TO TOW LOCOMOTIVE UNIT

When a unit is to be moved by an outside source of power, either as a dead-head unit in a train, or as a shutdown unit of the operating locomotive, the brake system should be set so it operates like the cars of a train. Instructions of the air brake manufacturer should be studied for the specific type of equipment involved. In general, for type 24-RL equipment, proceed as follows:

A. Shut down the engine, open the battery switch, place throttle and reverse lever off, and remove reverse lever.
B. Set air lines as follows:
   1. Place automatic and independent brake valves in running and release positions respectively, and remove handles.
   2. Close double heading cock.
   3. Set dead engine cock in dead(open) position.
   4. Turn Rotair Valve or Controlled Emergency Cut-out cock, whichever is installed, to Pass position.
   5. Open brake pipe branch pipe cut-out cock to D-24 control valve.

XVII. TO SHUT DOWN LOCOMOTIVE

A. Make sure the brakes are properly set, applying independent brake and hand brake as required. If units are customarily left in readiness for moving by another locomotive with air hose connected, close brake pipe cut-out valve on automatic brake pedestal.
B. Remove reverse lever from master controller.
C. Stop engines as previously directed, open control switch beside master controller (if closed), and open battery switch in electrical equipment cabinet.

Note 1. Yard movements usually involve idling prior to shutdown. However, if engines are quite hot, idle them for about ten minutes to dissipate heat.

Note 2. In freezing weather, protect engine cooling system. If locomotive is left unattended with engine running, remove reverse lever and set brakes.

XVIII. AIARMS AND PROTECTIVE DEVICES

Locomotives are regularly equipped with necessary protective devices. Their connections vary with individual requirements. A general description is given here which enables crews to determine the kind of installation on any specific locomotive. In general, protective devices on locomotives which cannot be used in multiple-unit operation, function locally without indication lights or audible alarms. When equipped

for multiple-unit operation, the indication is carried through to all units. A description of the most typical connections of such equipment follows. (Alarms for special equipment such as dynamic braking, speed controls, etc. are described in paragraphs on such equipment.)

A water temperature switch (On M.U. equipment only, unless specially installed) in the radiator system of each engine, operates automatically if the engine water temperature rises too high. It idles the hot engine, and rings the alarm on all units. On locomotives not equipped with such a switch, the operator should watch the temperature gauge to avoid operation at excessive temperature.

A ground relay is installed on each power unit, as described on page 405 . On multiple-unit equipment it rings the alarm bells also.

An engine shutdown indication (on M.U. equipment only) is received through an alarm relay which is connected in parallel with an engine shutdown magnet valve. The valve and relay are fed through the lube oil pressure switch which must be closed to maintain fuel supply. If the switch opens due to low oil pressure, or any engine stoppage, the alarm relay closes and rings the bells.

An emergency fuel cut-off valve is provided in the main suction line to the motor driven supply pumps. In case of fire or other emergency it may be closed to shut

off the fuel supply. It is closed manually by pulling the pull-rings in the cab, or outside the locomotive. Each unit is shut off independently. When this valve has been tripped, it must be reset manually to restore the fuel supply. It may be necessary to bleed air from the fuel line. Be sure the controls have been returned to their "off" position before starting the engine.

An engine overspeed stop is installed on the front of the camshaft casing at the generator end of the engine to protect the engine against excessive speed. It is a spring loaded tripping device, gear driven from the camshaft, and set to trip at a predetermined camshaft speed. The tripping operation actuates a plunger which moves the fuel control shaft to the no-fuel position and stops the engine. Before starting the engine again, the overspeed stop must be reset. Insert bar in housing and pull down.

XIX. MISCELLANEOUS

RUNNING THROUGH WATER

Care must be taken not to allow the traction motors to come in contact with water unnecessarily. In case of unavoidable operation of the locomotive over water covered track, the speed should be reduced. The locomotive should not be operated through water having a depth of more than three inches above the top of the rail.

OPERATING OVER CROSS-OVERS

The throttle should be retarded at about a car's length ahead of a cross-over to avoid excessive jar on gear teeth and to prevent pitting of commutators, which would be the result were the locomotive to be operated over cross-overs at full normal current.

INCIDENTAL REVERSING MOVEMENTS

The reverse lever of a live locomotive should always be set in the direction of travel, when drifting backward against slack, or when being moved by another locomotive. In many instances a neutral position would be sufficient. However, every precaution should be taken to insure that, during such movements, an application of power cannot be made in the opposite direction. Avoid drifting backward when starting up a grade.

WATER TEMPERATURE CONTROL

Electrically driven radiator fans are automatically regulated by a thermostatically operated temperature controller when the fan and shutter switch is in the "auto" position. If the automatic system does not function properly, make sure that the fan circuit breaker in the equipment cabinet has not opened. If the system does not function with this switch closed, by-pass the automatic controls by throwing the fan and shutter switch to the "on" position. Fans will then run at intermediate speed.

Shutters may be set manually on some locomotives (usually those not equipped for dynamic braking). If water temperature drops too low with the fan-and-shutter switch in the "on" position, partially close the shutters by disengaging the shutter control handle from its quadrant, and moving it as required.

RERAILING LOCOMOTIVE

Do not apply power to derailed driving wheels. A traction motor will be seriously damaged if power is applied without a load, as is the case when wheels spin freely. Isolate the unit by turning the engine control switch to "idle" and push with the other units.

SPEED RECORDER - OVERSPEED CONTROL

The standard speed indicator may have extra equipment to record train speed or automatically apply brakes if speed is excessive. Speed control, if installed, opens (de-energizes) the Overspeed Magnet Valve circuit under such conditions, which initiates a service application of the air brakes and idles the engines. The equipment may, or may not, have a recapture feature which gives the engineer a whistle warning, and a 6-second delay during which time he can reduce speed and suppress the automatic application of brakes. Operators generally receive instructions locally concerning details of their individual equipment. If a penalty application occurs, see foregoing paragraph IX concerning recovery.

HEADLIGHTS

Each headlight is individually controlled by a three position switch on the control stand. A resistor in series with the "dim" position of the switch dims the headlight. The circuit is fed through the control circuit breaker in the equipment cabinet.

CAB HEATERS

Each unit has a hot water cab heater equipped with an electric fan. Fan speed can be regulated by a rheostat incorporated in the cab heater switch. The fan motors are fed through the control circuit breaker in the equipment cabinet.

AUXILIARY GENERATOR SWITCHES

The auxiliary generator and exciter unit on the main generator frame is belt driven by the main generator. The auxiliary generator charges the battery, and supplies the 4-pole exciter field circuit, and small motors and control equipment operating at battery voltage.

A breaker type switch in the auxiliary generator power circuit affords overload protection by automatically opening if current is excessive. This switch is in the equipment cabinet and is normally kept closed.

A breaker type switch in the auxiliary generator field circuit is located on the control panel. It must be closed for normal operation but is opened when the locomotive is shut down, or during any starting of a diesel engine.

OPERATING DIFFICULTIES AND CAUSES

ENGINE FAILS TO TURN WHEN ATTEMPT IS MADE TO START

1. Battery switch open.
2. Emergency engine shutdown switch on control switch station may be closed. (M.U. locomotives).
3. Engine control switch may be "off".
4. Control breaker (35 amps. in cabinet) open.
5. Starting contactors may be stuck open.

ENGINE TURNS BUT WILL NOT FIRE OR IT WILL NOT CONTINUE TO RUN AFTER RELEASING THE START BUTTON

1. Fuel tank empty.
2. Emergency fuel shut off valve has been tripped.
3. Engine overspeed stop has been tripped.
4. Clogged fuel filter or strainer.
5. Fuel system not primed properly.
6. Fuel pump switch open or pump not functioning properly.
7. Insufficient lubricating oil pressure to keep the low pressure switch from operating.
8. Engine shut down cylinderor magnet valve not operating properly.
9. Insufficient oil supply in the governor.

ENGINE RUNS BUT ENGINE SPEED WILL NOT INCREASE WITH THE THROTTLE SETTING

1. Engine control switch in the "idle" position.

2. Throttle magnet valve not operating properly.
3. Insufficient control air pressure.
4. Faulty governor, or governor actuator.
5. Control switch not "on", - if locomotive has two controllers, switch at other stand not "off".
6. Hot water switch closed. (M.U.loco.)
7. Ground relay tripped.
8. Fan relay tripped. (Dynamically braked locomotive)

ENGINE OVERHEATS

1. Insufficient water supply.
2. Automatic shutter control not operating properly. Try fan and shutter switch in "on" position.
3. Engine overloaded.
4. Faulty fan motor circuit. Check fan breaker and contactors.
5. Cooling system circulating pump not functioning.

ENGINE STOPS

1. Fuel tank empty.
2. Low lubricating oil pressure, causing engine shutdown valve and cylinder to operate.
3. Emergency fuel shutoff valve has been tripped.
4. Engine overspeed stop tripped.
5. Emergency engine shutdown switch closed. (M.U.)
6. Failure in fuel supply system.
7. Fuel pump switch (breaker) has opened.
8. Clogged fuel filter or strainer.
9. Shutdown valve not energized.

LOCOMOTIVE DOES NOT MOVE WHEN THROTTLE IS OPENED

1. Reverse lever in "off" position.
2. Power cut-out switch open.
3. Engine control switch, or control stand control switches, improperly set.
4. Power knockout switch fails to close.
5. Auxiliary generator field switch open.
6. Auxiliary generator switch has opened.
7. Out-interlocks fail to close on generator starting contactors.

BATTERY AMMETER SHOWS DISCHARGE (ENGINE RUNNING)

1. Auxiliary generator switch open.
2. Auxiliary generator field switch open.
3. Poor contacts on battery contactor or reverse current relay.

NO DYNAMIC BRAKING EFFORT - See page 505

- SUPPLEMENTING MULTIPLE-UNIT NOTATIONS -

The foregoing instructions have covered (1) single unit, (2) multiple unit, and(3) M.U. dynamically braked locomotives. When requested by purchaser, types 2 and 3 purchased on any single order, and probably on successive orders, can be arranged to multiple with each other. However, operators should make sure that locomotives of different types are so arranged before operating in multiple. * In such instances, operation can be conducted along the following lines.

(a) With Multiple Unit (non-braking) type in control. - All units will work in motoring, but no unit will brake dynamically.

(b) With Dynamic Braking on all units in multiple. - All units will motor or brake, any unit can control.

(c) With M.U. Dynamically Braked Type in Control, Coupled to Non-braking Unit. - All units will work in motoring. When controls are set for braking, only the controlling unit will brake dynamically. The non-controlling unit will not brake dynamically, but power circuits are broken so it does not motor. However, the diesel engines on non-controlling unit continue to run, pump air, charge battery, etc.

* PRR No. 8954 to 8965 may be operated in multiple.

F U E L O I L S Y S T E M

Fuel is supplied to the engine by a motor driven supply pump which draws fuel from the tank through a suction strainer and forces it through a pressure filter into the fuel oil header, where it supplies the injection pumps. There is a gravity return line from the header to the tank. A pressure relief valve limits fuel pressure in the header to 25 psi, by-passing excess fuel back to the tank. The supply pump is protected against pressure by a relief valve connected to its discharge. The suction strainer and filter cartridges should be cleaned or renewed periodically.

The tank is suspended from the underframe between trucks. It is provided with filler and full depth sight-level gauges on each side of the locomotive. The manually operated cut-off valve in the suction line is described on page 220.

LOSS IN FUEL OIL PRESSURE

The fuel oil pressure gauge on the control panel should normally read 25 pounds. A loss in fuel oil pressure may be the result of one or more of the following causes.

1. Fuel pump failure.
2. Fuel switch opened.
3. Plugged fuel filters.
4. Leak in suction strainer.
5. Plugged suction strainer.
6. Pressure relief valve stuck open.

LUBRICATING OIL SYSTEM

The lubricating oil is drawn from the sump, formed by the bedplate of the engine, through a suction strainer by the engine driven pump. The pump forces the oil through an oil filter, a metal edge type strainer, and a heat exchanger. The oil is then delivered to the engine header, which distributes the oil to all parts of engine requiring lubrication. The pressure gauge in the cab should read between 50 lb. and 55 lb. (This is equivalent to 65 lb. at the header.) Should pressure become excessive, a relief valve will spill the pump output back to the engine base. Another relief valve by-passes the heat exchanger if its pressure drop is excessive.

The oil level in the sump should be checked daily and must be maintained above the "low" mark. To fill the crankcase, pour the proper type of oil through the filler pipe. Fill to the "full" mark on the bayonet gauge. To drain oil from the engine, open the crankcase drain valve. Also remove the plugs from the bottom of the camshaft trough, and be sure to drain the strainers, the filter and the heat exchanger, when changing crankcase oil.

LUBRICATING OIL PRESSURE

Lubricating oil pressure for each engine on the locomotive registers on a gauge at the corresponding engine control panel. Any perceptible deviation from recommended pressure (50 lb.) should be investigated. This corresponds to 65 lb. at

the header. Handles on metal edge strainers should be given two full turns every four hours to avoid clogging. Low oil pressure may result from one or more of the following:

1. Low oil level.
2. Hot or diluted oil.
3. Leak in pressure system; check for broken lines or loose connections.
4. Faulty pump.
5. Clogged suction strainer.
6. Clogged pressure strainer.
7. Clogged heat exchanger.

COOLING WATER SYSTEM

Water is circulated through the engine, heat exchanger and cooling radiator by an engine driven pump. An expansion tank vented to the atmosphere through an overflow pipe acts as a reservoir for maintaining a full system. The water level in the expansion tank must be maintained above the bottom of the gauge. This gauge is at the rear of the expansion tank. If leaks are suspected, the crew should endeavor to locate them while engine is warm, and report to maintainer. However, the packing gland of the water pump is adjusted to leak about 3 or 4 drops per minute normally.

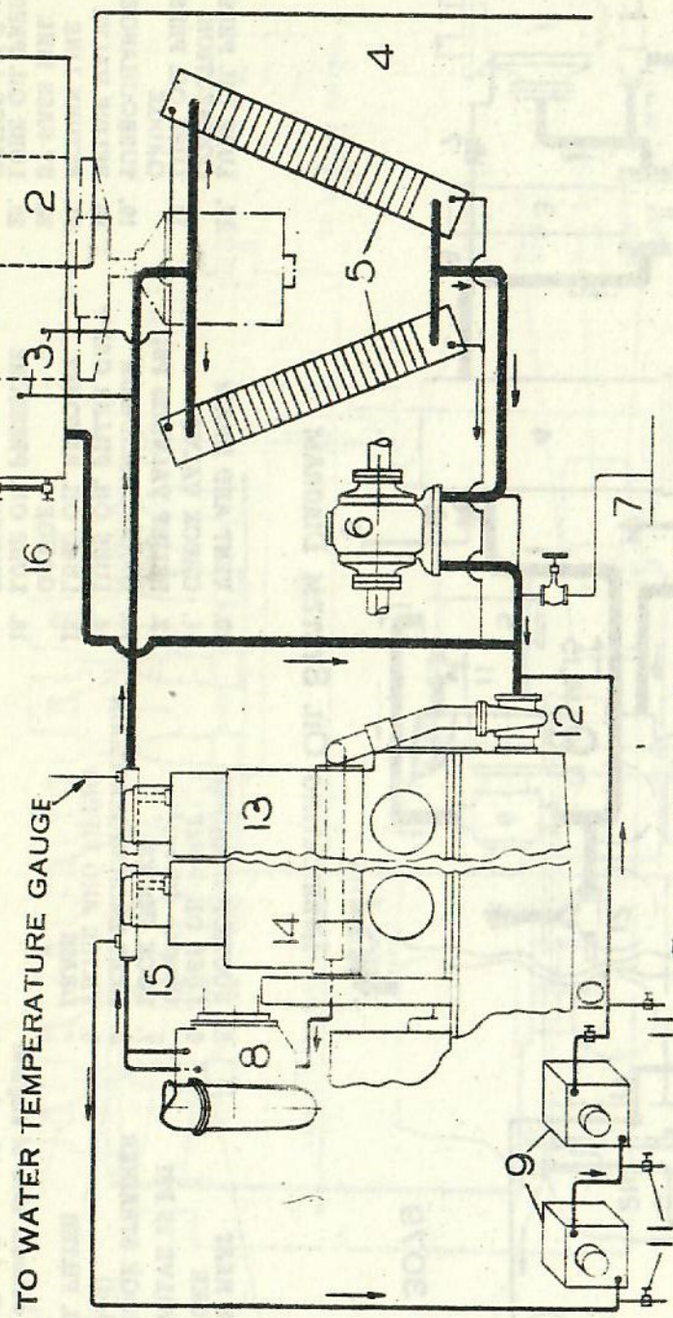
To fill the system add water through filler lines located underneath the train on each side of the locomotive near the middle of each truck. The system can be filled through the filler on the roof near the front, but it is not recommended because of the danger of trapping air in the system. If the engine overheats because

of low water level, idle the engine and add hot water if possible. If it is necessary to use cold water, it should be added very slowly.

Possible causes of overheating are listed under Operating Difficulties in the preceeding section of this book. For details of related equipment on Shutter Valves, Shutter Limit Switches, Manual Shutter Control and Radiator Fan Controls, consult these respective entries in the index.

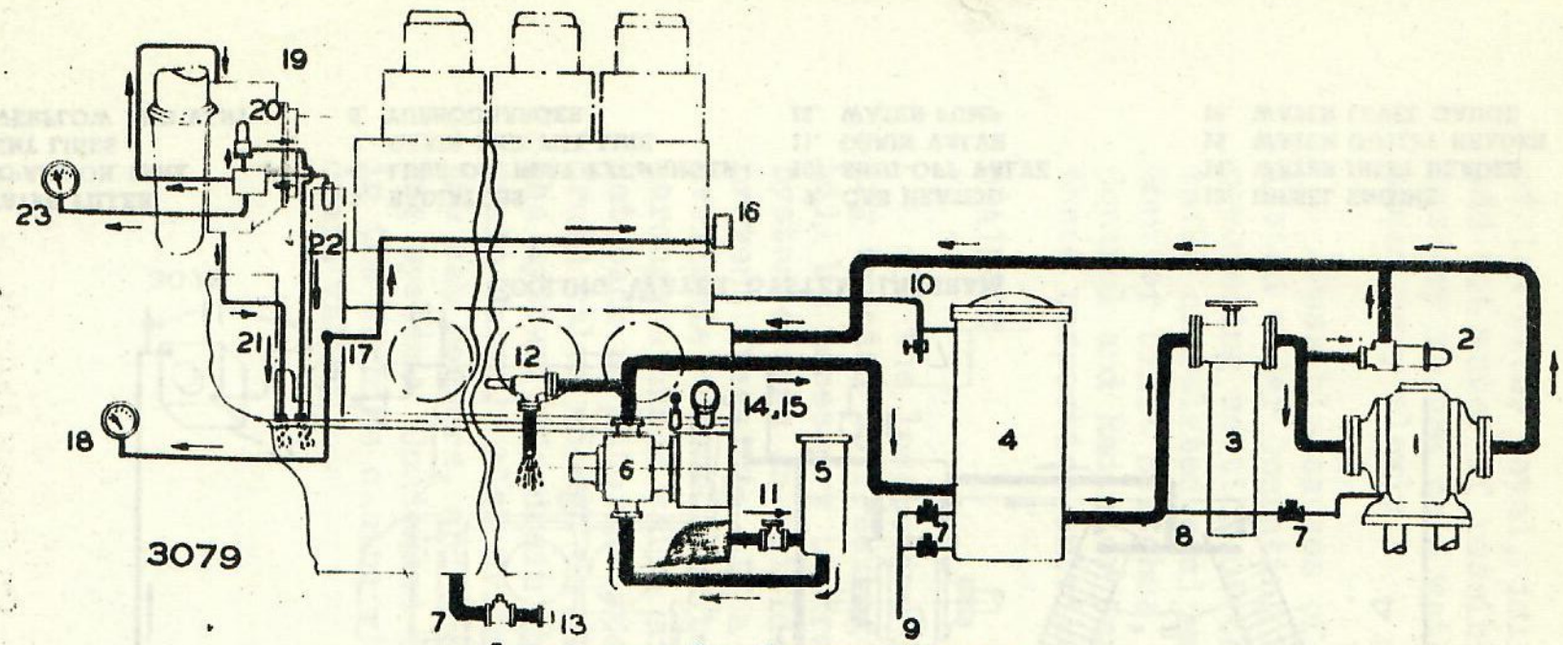
DRAINAGE

If the locomotive is to be left standing exposed to freezing temperature, it will be necessary to drain the cooling system or use an outside source of steam to prevent freezing. If a steam source is available, connect it to the drain pipe through a check valve so that the water can not back up into the steam line. Open the drain valve enough to allow steam to enter the system. To drain the system, open the drain valve. Also drain the heat exchanger, the cab heaters, and the turbocharger cooling system. Condensed water may accumulate in the turbine casing which has a separate drain valve.



Cooling Water System Diagram

1. WATER FILLER
2. EXPANSION TANK
3. VENT LINES
4. OVERFLOW AND VENT
5. RADIATORS
6. LUBE OIL HEAT EXCHANGER
7. DRAIN AND FILL LINE
8. TURBOCHARGER
9. CAB HEATER
10. SHUT-OFF VALVE
11. DRAIN VALVE
12. WATER PUMP
13. DIESEL ENGINE
14. WATER INLET HEADER
15. WATER OUTLET HEADER
16. WATER LEVEL GAUGE

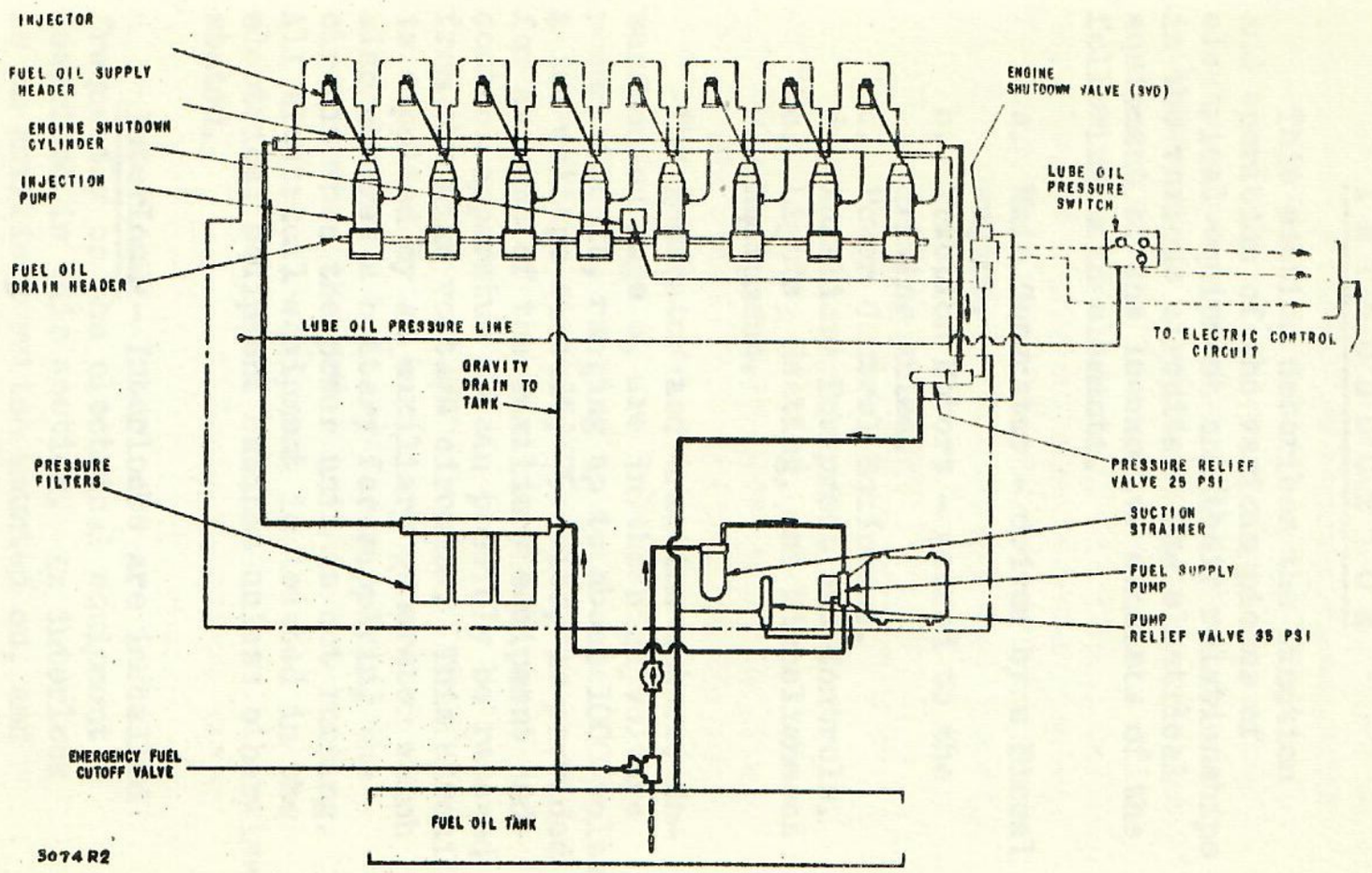


LUBRICATING OIL SYSTEM DIAGRAM

1. LUBE OIL HEAT EXCHANGER
2. RELIEF VALVE 25 PSI
3. METAL EDGE STRAINER (if installed)
4. LUBE OIL FILTER
5. SUCTION STRAINER
6. LUBE OIL PUMP (Engine driven)*
7. LOCK COCKS
8. HEAT EXCHANGER DRAIN
9. FILTER AND PIPING DRAIN
10. VENT AND DRAIN
11. CHECK VALVE
12. RELIEF VALVE/25 PSI
13. CRANKCASE DRAIN
14. LUBE OIL FILLER CAP**
15. LUBE OIL BAYONET GAUGE**
16. LUBE OIL PRESSURE SWITCH
17. LUBE OIL PRESSURE CONNECTION
18. LUBE OIL PRESSURE GAUGE
19. TURBOCHARGER
20. RELIEF VALVE
21. RETURN LINE
22. BY-PASS LINE
23. LUBE OIL PRESSURE GAUGE (at Turbo)

*Located at exhaust side of engine.
**Located on Fuel Pump side of engine.

FUEL OIL SYSTEM DIAGRAM



E L E C T R I C A L E Q U I P M E N T

I N T R O D U C T I O N

This section describes the function and operation of the various pieces of electrical equipment and their relationships in the various circuits. The electrical equipment of the locomotive consists of the following main elements.

a. Main Generator - driven by a Diesel engine.
b. Traction Motors - geared to the driving axles.
c. Power Control Equipment.
d. Auxiliary Equipment and Controls.
e. Lights, Heating, and Miscellaneous Equipment.

The generator and traction motors, described on page 6, are in the high voltage power circuit, ranging up to about 1000 volts. A low voltage circuit, 75 volts, is provided for as much of the auxiliary equipment and control apparatus as can possibly be removed from the high voltage circuits. This circuit is supplied by an auxiliary generator which also charges a battery for supplying the circuit when the power unit is not running. All electrical equipment is located in the electrical equipment cabinet unless otherwise stated.

Interlocks - Interlocks are installed frequently on the electrical equipment described in this section. An interlock is an auxiliary switch mounted on, and

controlled by, another switch, contactor, valve or similar control equipment. It is operated by a cam or mechanical linkage which is so connected that the opening and closing of the auxiliary circuit is dependent on the operation of equipment in the main circuit. They are used to control the sequence of operation, or to permit making or breaking related circuits only when proper conditions exist. The chief concern to the operator is that sluggish or faulty interlocking can cause faulty locomotive operation.

MAIN POWER CIRCUITS

In addition to the generator and traction motors, the high voltage circuits include power switches and a reverser controlling the traction motors, fans for cooling the engine radiator, and relays in the field shunting circuits of the fan and traction motors, and relays in the indicator circuits for wheel slip and grounds, as described below.

PNEUMATIC POWER SWITCHES

Electro-pneumatically operated power switches connect the traction motors to the generators. They close when their coils are energized by the closing of the power control contactor.

REVERSER

The reversers control the direction of rotation of the traction motors by

reversing the direction of current through the field windings, thereby reversing the direction of locomotive travel. A pneumatically operated cylinder rotates the drum to change connections. The cylinder is controlled by magnet valves which are connected to a small reverser drum in the master controller. The reverser is located in the equipment cabinet. If it does not rotate in response to the controller setting, the plunger button on the magnet valve may be pressed in, or a lever may be applied to the handle at the bottom, to move it manually.

TRACTION MOTOR FIELD SHUNTS

The traction motor fields are shunted to provide a by-pass for a portion of the field current after the locomotive speed has reached a point where full Diesel engine power output under normal field strength is not absorbed. The field is automatically weakened in several steps, thus increasing speed and making use of full power output over a wider locomotive speed range than would be otherwise possible. The field shunting controller is connected across main generator voltage so that its rotating element energizes a successively greater number of field shunting contactors as locomotive speed increases. The field shunt resistors arelocated on the equipment cabinet.

RADIATOR FAN MOTORS

Two fan motors near the roof of the radiator compartment are connected in series to the main generator through a protective

circuit breaker. They operate at three speeds which are automatically determined by engine water temperature (See Fan Control System). Motor connections are as follows:

Low Speed - Partial generator voltage across the fan motors, tapping power from a point between the traction motors.

Medium Speed - Full generator voltage across the fan motors.

High Speed - Fan motor fields are shunted - full generator voltage retained.

A relay in the fan motor field shunting circuit opens if the main generator voltage is high (about 625 volts or more) in order to prevent field shunting and protect the fans against excessive speed. High fan speed is generally needed only when water temperature is rising while generator voltages are low.

WHEEL SLIP RELAY

The wheel slip relays automatically reduce the power whenever the wheels slip. The coil of the relay is connected between the traction motors and the wheel slip resistor so that, under normally balanced conditions, no current flows through the coil. When a pair of wheels slips, the unbalanced voltage condition causes current to flow through the coil to close

the relay. The contacts of the relay give a buzzer warning to the engineer and energize the throttle valve which reduces the speed of the engine. Each power unit has its own wheel slip relay and throttle valve, which function independently of the other unit. Engine speed is reduced only on the slipping unit, and power is automatically restored when slipping stops. On multiple unit equipment, the buzzer is train-lined to all units.

GROUND RELAY

If the high voltage circuit becomes grounded, a ground relay is energized on the faulty unit. Each unit has its own relay and independent protective circuit, and operation of the adjacent unit is not affected. The ground relay drops the load on the engine by de-energizing (opening) the exciter and generator field contactors, idles the engine, and lights the ground indicator light on the control panel. A ground relay reset button may be pressed to resume normal operation if the ground was temporary. A cutout switch may be opened for emergency operation if necessary. Crews should observe any limitations imposed by the operating rules of their own company covering this condition.

MAIN CONTROL CIRCUIT

The main control circuit consists of two master controllers and various contactors and relays for the control of power to the traction motors. It is a low voltage circuit (about 75 volts). Only

one controller at a time is operative, but circuits pass through both controllers to insure certain interlocking protection. The master controller was described on Page 2.

CONTROL SWITCH AND MASTER CONTROLLER VALVE

The control switch at the engineer's position must be in the "On" position to complete the circuit through the controller, and the corresponding switch on the other stand must be "Off". One wire through this switch feeds the power knockout circuit described in next paragraph, and another wire feeds the Master Controller Valve which determines which throttle is connected to the pneumatic control lines. On multiple unit equipment, the control switches are train-lined so that the first switch to be closed interlocks all other control switch circuits in an open or inoperative condition.

A control breaker in the cabinet is a protective switch feeding several circuits. It is normally left closed on all units and should not be confused with the control switch just described.

ENGINE CONTROL SWITCH

A rotary Engine Control Switch for each power unit may be set to three positions, "on", "idle" and "off". It enables the operator to idle or stop an engine without cutting out locomotive control circuits. In the "idle" position, the engine continues to run, pump air, charge the battery and keep the radiator system functioning.

(This is sometimes called "isolating a unit"). In the "off" position the entire unit is shut down.

POWER KNOCKOUT SWITCH AND CONTACTOR

The master controller is fed through Power Knockout Contactor. The contactor's coil is fed through a pneumatically operated Power Knockout Switch which opens when an emergency brake application is made. When the Knockout Switch opens, this contactor is de-energized (opened), the control circuit becomes inoperative, the power is shut off and the engine is reduced to idling speed. When the brakes are restored to normal and the throttle returned to "Off", the Power Knockout Switch closes automatically and energizes this contactor. It is then kept energized (closed) through an in-interlock, regardless of the setting of the controller, until either the control switch is opened, or an emergency brake application occurs.

POWER CUT-OUT SWITCH

Each power unit has a manually operated 2-pole cut-out switch which when opened, completely disconnects the fields and power circuits of the unit. It is a normally closed breaker-type switch which opens automatically if overloaded.

POWER CONTROL CONTACTOR

The power control contactor is energized when the throttle is advanced (providing the reverse lever is set for forward or reverse travel). It closes when energized

which, in turn, energizes (closes) the pneumatic power switch to complete the main power circuit. Therefore, the traction motors are connected to the generator only when they are receiving power. On locomotives equipped for dynamic braking, this contactor must close in order to complete the braking circuit.

THROTTLE VALVE

The throttle valve on each unit may be energized by protective devices to reduce the pneumatic pressure on the governor and decrease the fuel supply to the engine. Pressure (and fuel) automatically return to the original value as soon as the valve is de-energized. The most frequently used devices are the wheel slip relay, generator field interlocks, ground relay and water temperature switch. Some of these are connected on M.U. equipment only. If the valve is repeatedly actuated by the wheel slip relay the throttle lever should be retarded.

A U X I L I A R Y C I R C U I T S

FAN CONTROL SYSTEM

The fan and shutter switch connects the cooling system controls to the low voltage circuit. It is a double-pole double-throw manually operated switch on the engine control panel with three positions as follows:

Off - Fans will not operate.

Automatic - Fan speed automatically regulated by temperature switches.

On - Fans operate at medium speed only, (for use if automatic control fails).

The temperature control switches, on the radiator compartment bulkhead, are actuated by an engine temperature thermostat. When the fan and shutter switch is in the automatic position, their operation is in a fixed relationship to water temperature, so that the fan contactors change the speed of the fan motors. The temperature control switches are not in the circuit when the fan and shutter switch is in the "on" position.

Shutter valves in the fan control circuit regulate the position of the radiator shutters. The shutters permit air to pass over the radiator when the fans are cooling the engine. On dynamically braked locomotives, they direct the air over the braking resistors when the fans are cooling the braking circuit.

STARTING CONTACTORS

Starting contactors connect the generator to the battery when Start Button on the engine control panel is held in. Their coils are fed through the engine control switch. When they are closed, current from the battery flows to the main generator which now acts as a motor and cranks the diesel engine. The shutdown valve (described in next paragraph) is also energized at this time to supply fuel. When the engine fires,

and lube oil pressure builds up, the lube oil switch picks up. This de-energizes (opens) the starting contactors, disconnects the generator from the battery, and connects the shutdown valve to the battery through the normal operating circuit. The start button may be released after the lube oil pressure indicates 20 pounds.

A second pole on each start button opens when the button is pressed in, thus preventing simultaneous operation of more than one starting circuit.

ENGINE SHUTDOWN VALVE

This solenoid-operated valve on the engine controls the fuel supply. Its coil must be energized to maintain fuel supply. A circuit through the starting button energizes this coil when starting the engine. As soon as oil pressure builds up, the lube oil pressure switch closes and keeps the coil energized. When the engine is operating, it shuts down if de-energized by opening the Engine Control Switch or the Lube Oil Pressure Switch.

LUBE OIL PRESSURE SWITCH

Each unit has a Lube Oil Pressure Switch mounted on the engine, which automatically opens when lubricating oil pressure drops below a predetermined value. It acts on Shutdown Valve as just described.

FUEL SUPPLY PUMP AND SWITCH

The motor driven fuel supply pump for each power unit receives power through a manually operated single-pole breaker-type switch located on each of the engine room control panels. The compound-wound motor mounted on the bedplate on the valve gear side of each engine operates at constant speed, supplying fuel oil from the supply tank to the engine fuel injection pumps.

MISCELLANEOUS ELECTRICAL EQUIPMENT

There are several other pieces of equipment in the various control circuits which function automatically and normally require no attention from the operator.

A voltage regulator holds the auxiliary generator voltage constant. Its vibration and sparking may be heard at close range. This is normal and no adjustment should be attempted by unauthorized personnel.

A reverse current relay and contactor connects the auxiliary generator to the battery. When generator voltage is sufficiently high to charge the battery, connection is maintained. The reverse current feature breaks the connection anytime the voltage is low enough to drain the battery.

A load regulator is connected in series with the exciter 4-pole field circuit. It automatically changes the resistance in the field circuit, thereby changing the

strength of the field to adjust the load on the electrical equipment. Its main function is to reduce the field strength, and hence the power output of the main generator, whenever the engine tends to become overloaded. The description in the maintenance bulletin should be understood before making any adjustments to the regulator.

BREAK-IN-TWO PROTECTION

A magnet valve on each multiple unit locomotive, energized from the adjacent locomotive, provides against loss of air in the throttle control line of the leading unit if faulty end-connections arise, in accord with I.C.C. Rule No. 205. In most instances, the crew will be aware of normal functioning of this equipment. In addition, failure of the trailing unit to respond to throttle settings when there has been no break should lead crews to investigate for sticking valve (RBPV or FBPV), or poor electrical connection.

D Y N A M I C B R A K I N G

Transfer locomotives may be equipped with a dynamic braking system which retards a train by converting its moving energy into electrical energy. The power normally dissipated at the brake shoes is used in dynamic braking to drive the traction motors which act temporarily as electric generators. Electrical connections are changed automatically when the master controller is set for braking. The power required to turn the traction motors checks the speed of the locomotive. The energy thus produced is fed to large resistance coils in the upper section of the radiator compartment, where the heat is dissipated to the atmosphere by fans. Variable braking effort is obtained by changing the throttle which controls the traction motor field excitation. The excitation current is supplied by the main generator.

Dynamic braking supplements the standard air brake equipment. Its use, particularly on long, descending grades, serves to reduce wear on brake shoes and prevents the excessive heating of wheels which would occur with constant application of train air brakes. The maximum speed at which dynamic braking is practical is about 60 miles per hour. Above 60 mph use the air brakes only. As the dynamic braking effort fades out at low speed, use the automatic air brakes, as necessary. Avoid a quick run-out of the head end whenever regular operation is resumed. Dynamic braking necessarily bunches the train, and slack should always be adjusted gradually.

Dynamic braking is controlled by the throttle and reverse lever, and may be supplemented by small applications of air to the train brakes if necessary. However, the two braking systems are interlocked to prevent their application at the same time on the locomotive. Typical instances of the use of air brakes during dynamic braking are as follows:

(a) The dynamic brakes will not stop a train because the braking effort fades out at slow speed, and an application of air is necessary.

(b) Air may be used if grade or tonnage tends to increase the speed above sixty (60) miles per hour.

(c) Air must be used to control train speed through restricted zones below sixty (60) miles per hour, if the maximum dynamic braking limits have been reached.

OVERLOAD PROTECTION

Amperage during braking, as indicated in the load ammeter, should be kept within the limits stated on the load-limit plate in the cab. If load limits are closely observed, overload protective devices will seldom function. However, their action should be understood by the operators if they should happen to function. A brake limit relay is provided to give a warning

on an indicating light if load becomes excessive. The operator should immediately retard the throttle if this light comes on.

If each power unit is equipped with two limit relays, the second relay energizes a brake regulating valve which automatically acts on the load regulator to reduce the load.

FAN DIFFERENTIAL RELAY

A fan differential relay is installed to prevent dynamic braking if the fan motor circuit is defective. When this relay is actuated it opens the field excitation circuits and idles the engine. Suitable alarm and indication lights enable the crew to determine the nature and location of the trouble. The relay has a holding coil which keeps it closed after it has picked up. If the defect was of a temporary nature or has been rectified, pressing the fan relay reset button momentarily will restore the circuit to normal. If the trouble persists, a cutout switch in the circuit should be opened to stop the alarm, and restore excitation so that the radiator fans operate. The engine continues to idle and the power control circuit is opened when this switch is opened. Braking effort is lost only on the defective unit.

CAM SWITCH

Traction motor connections during dynamic braking differ from that during motoring. A cam switch controls the change-over. It has a motoring position and a braking position, and is pneumatically

operated by two magnet valves built into the switch in much the same manner as in the reverser. Several fan control and power control circuits are fed through interlocks in this switch.

SHUTTER LIMIT SWITCHES

The position of the shutters on the cooling system during braking differs from the position during motoring. Shutter limit switches are mounted so that mechanical interlocking prevents the functioning of braking or motoring control circuits unless the shutters are properly set.

TO APPLY DYNAMIC BRAKING

1. Move throttle to the "off" position.
2. Move reverse lever to "dyn" position. (Trip a small latch under the lever to release it).
3. Advance throttle to first notch.
4. After a few seconds, when load ammeter shows a dynamic braking current, advance throttle gradually to increase braking effort
5. Load ammeter reading should not exceed 750 amperes at 60 miles per hour, Load at slower speeds increases slightly up to a maximum of 825 amperes at 18 miles per hour.
6. To decrease braking effort, retard throttle.
7. To resume normal operation:

   a. Move throttle to "off" position. Allow 4 to 6 seconds for circuit to changeover.

   b. Move reverse lever to adjacent motoring position.
   c. Adjust slack gradually, then apply power as desired.

There will be no dynamic braking effort if

   a. The shutter limit switches fail to close.
   b. The fan relay picks up. (Faulty fan operation).
   c. The ground relay picks up.
   d. The cut-out switch in the fan (braking) circuit is open.
   e. The power cut-out switch (breaker) trips open.
   f. The engine control switch is not in the "on" position.

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